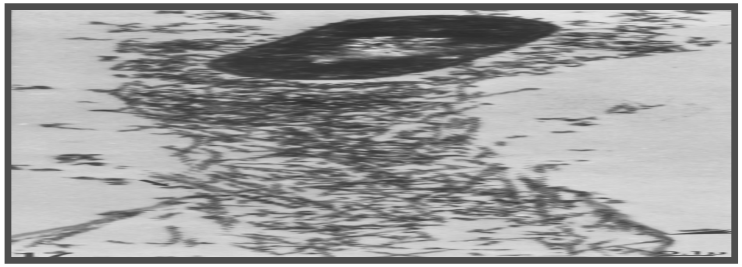
Statistical Field Theories and Collective Phenomena

Mehran Kardar, MIT, DMR-01-18213

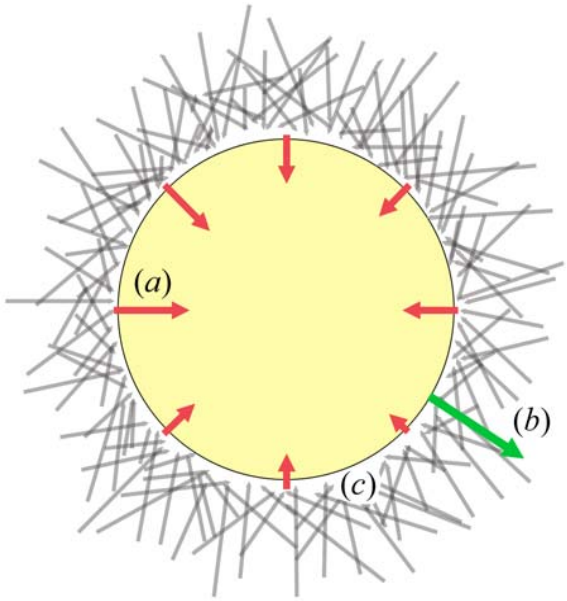
Symmetry-Breaking Motility

[with Allen Lee & Ha Youn Lee]

Motility, the capacity of organisms for independent motion, has long fascinated physicists as well as biologists. One strategy for movement is propulsion via forces generated by the polymerization of actin on an organism's surface. We have constructed and analyzed a simple model for this type of motility, treating the actin filaments around a given object as a continuous dynamical field. Our model gives insight into the relationship between the shape of a motile object and its motion.



Tilney and Portnoy, *The Journal of Cell Biology* **109** (1989)

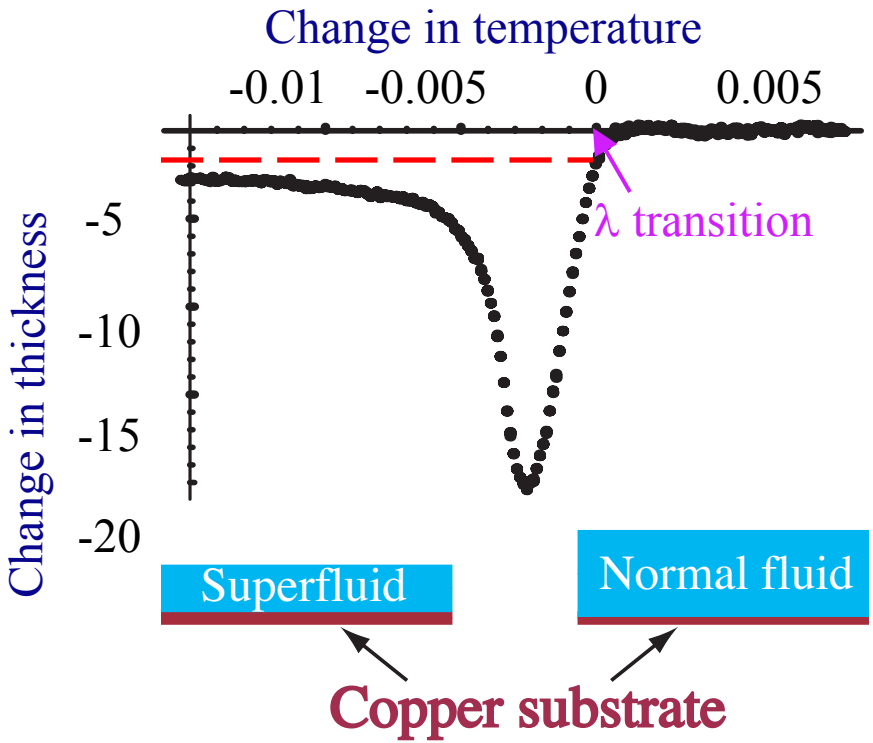


Casimir forces, Surface fluctuations, and thinning of Superfluid films

[with Roya Zandi & Joseph Rudnick, Phys. Rev. Lett. (2004)]

Recent experiments on the wetting of ^{4}He have shown that the film becomes thinner at the λ transition, and in the superfluid phase. The super-fluid state, in which a continuous symmetry is broken, supports Goldstone modes that are not present in the normal phase. Confinement of these long wavelength modes give rise to fluctuation-induced (Casimir) forces which result in thinning of the film. However, the observed thinning of the film is larger than can be accounted by this Casimir force.

We focus on the thinning of the film well below the transition and find that the flow field generated by *surface* fluctuations leads to a force favoring thinner films. This force has the same form as that arising from bulk Goldstone modes, but its amplitude is almost twice as large.



The dashed line shows the expected change in the thickness of the film well below the transition due to the combination of surface and bulk fluctuation-induced forces. The meaningful comparison between the dashed line and the data is on the left hand side of the figure.